

compensation pixel values are generated to replace missing data from defective pixels.

Applicants traverse this ground of rejection. The references, viewed individually or in combination, do not teach or suggest applicants' advantageous method for capturing and processing image information within the meaning of 35 U.S.C. § 103.

Applicants' claimed method and apparatus are directed to recovering missing color data in a two-dimensional color array. The method and apparatus involve the application of two one-dimensional non-linear interpolation processes. Generally speaking, applicants' method essentially "decouples" the conventional two-dimensional process into two one-dimensional processes. The first one-dimensional color recovery process generates intermediate second color image data from the sampled first color image data and the second one-dimensional color recovery process generates the desired third color image data from the second color image data.

As described in detail in the application (see, for example, page 8, line 28 to page 10, line 14) a two-dimensional array of discrete image sensing elements, each of which is specifically responsive to one of at least three predetermined colors (e.g., red, green and blue) is exposed to image information-bearing illumination to obtain a collection of each electronic information signal received from each discrete element. The collection of signals forms the raw unprocessed one-color image data from which fully recovered third color image data can be derived.

The first step towards deriving the fully-recovered third color image data is to first recover missing color information along a first dimension (e.g., along rows of the array) by interpolating the first color image data along the first dimension to provide a first-interpolated color data for each of the discrete elements, forming a difference channel between the first color image data and the first interpolated color data and then applying a one-dimensional non-linear filter on the difference channel and

combining with the first color data to obtain the first recovered image data. The second color image data comprises a combination of the first recovered image data and the first color image data.

The second step of the method derives fully-recovered third color image data from the two color image data by recovering missing color information along a second dimension, e.g., along columns of the array. The second color image data is obtained by interpolating along the second dimension to provide second interpolated data for each of the discrete elements, forming a difference channel between the second color image data and the second interpolated data and then applying a one dimensional non-linear filter on the difference channel and combining with the second color data to obtain the second recovered image data. The third color image data comprises a combination of the second recovered image data and the second image data.

The method of applicants is not taught or suggested by the references. The primary reference, Ercan et al, describes a digital imaging process which is remote from that of applicants. As mentioned by the examiner, Ercan et al teaches steps (a) and (b) of applicants' method, which steps are generally known in the art. However, also as acknowledged by the examiner, this reference does not relate to the recovery of missing image information and therefore does not teach or suggest applicants' claimed method.

Ercan et al relates to a black and white imaging method and is directed to improving the contrast of a digital image to accentuate important image details. Areas of the image requiring improvement are identified as those with a narrow range of pixel values and having a median value that is significantly different than the median pixel value of other parts of the image. Proposed corrections act toward bringing the median value of the area more toward the average value and increasing its contrast. In another aspect of the invention, two different cameras are used to take pictures at

different exposures and image processing is used to provide a composite picture with well-exposed detail in all areas of the image.

The image obtained by Ercan et al is not described as having any missing data and the processing described is for the purpose of improving the visibility of existing image detail whereas the method of applicants involves the recovery of missing data.

Heller et al, which has been cited as the secondary reference, does not render the rejection any more effective. Heller et al deals with correcting defective pixels on image sensing elements. Generally, the method of Heller et al involves using certain pixels of the image sensor to obtain the missing information and stores the location of the defective pixel and of the corrective pixels on the integrated image sensing device itself. Two embodiments are described (see, for example, column 8, lines 57 – 65). In one embodiment, compensation pixel values are generated by examining the pixel values surrounding the defective pixel. In the other embodiment the pixel value of a pixel that precedes the defective pixel is used as the compensation pixel value.

The disclosure of the reference is silent as to the color of the pixels which are used to provide the compensation values; however it can be inferred that pixels of the same color are used to obtain the compensation values. It should also be noted that both embodiments of Heller et al use linear filters and there is no explicit teaching of the use of non-linear filters as are used in the method of applicants. Applicants' method involves the use of second color data and non-linear filters and the method of Heller et al does not. Applicants' method also assumes that data is available at all pixels and therefore that defective pixels, such as are addressed by Heller et al do not exist or have been previously compensated.

It is readily apparent that one skilled in the art and knowing of the disclosures of the references would not be placed in possession of applicants' advantageous claimed method and apparatus. In order to properly support a rejection of the claims in an application a reference or references must include teaching(s) which would

provide an incentive for those skilled in the art to modify the teaching(s) of the references to arrive at the claimed subject matter. Here it is readily apparent that the teachings of the references cannot be combined to arrive at the claimed method and apparatus of applicants.

Reconsideration of this ground of rejection and withdrawal thereof are respectfully requested.

2. Claims 2 and 7 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Ercan et al in view of United States Patent Application Publication No. US2002/0081019 A1 ("Katayama et al"). In support of the rejection the examiner has generally asserted that although Ercan et al does not specify pattern-wise arrangement of image sensors, Katayama et al does teach providing an image sensing apparatus which determines whether the optimum image sensing conditions are achieved or not by judging whether there is a predetermined pattern in an image sensing field.

Method claim 2 is dependent on claim 1 and apparatus claim 7 is dependent on claim 6. These dependent claims are drawn to a preferred embodiment of applicants' invention wherein the discrete sensing elements are arranged in a pattern such that (a) no two discrete elements that are contiguous along the first or second dimension are specifically responsive to the same one of the at least three predetermined colors and (b) no more than one discrete element is contiguously between two discrete elements that are specifically responsive to the same one of the at least three predetermined colors.

Claims 2 and 7 include, respectively, all the limitations recited in claims 1 and 6 and are patently distinguishable over the references for the same reasons described above with respect to Ercan et al and, further, because Katayama et al does not teach or suggest the embodiments of applicants' invention recited in claims 2 and 7.

Katayama et al is directed to image sensing apparatus capable of placing an object, whose three dimensional shape is to be generated, under the optimum image sensing conditions upon sensing the object from a plurality of image sensing points. This reference is not directed to recovering missing color information.

Reconsideration of this ground of rejection and withdrawal thereof are respectfully requested.

3. Claims 3 – 5 and 8 – 10 have been rejected under the first paragraph of 35 U.S.C. § 112 as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention. In support of the rejection the examiner has asserted that applicants should specify the specifications and parameters for rank-order filters in claims 3 and 8 and claims 4, 5, 9 and 10 should have the complete specifications of red, green and blue wavelengths.

Applicants traverse these grounds of rejection. Claims 3 – 5 and 8 – 10 satisfy all the requirements for patentability recited in Section 112. It is beyond dispute that the wavelengths present in the red, green and blue regions of the spectrum are well known to those skilled in the art. Thus, the specification describes that in a preferred embodiment the three predetermined colors are red, green and blue. This statement, without more, is sufficient to satisfy the requirements of the first paragraph of Section 112 for this embodiment.

Rank-order filters are also well known to those skilled in the electronic image capture and processing art. In the paragraph bridging pages 14 and 15 applicants have taught that a particular class of non-linear filters capable of removing narrow peaks and valleys within the color-difference data and which therefore are suitable for use in the claimed method and apparatus, are rank-order filters. It is further taught that in a preferred embodiment a median rank-order filter is used. A suitable rank-order filter

is described in U.S. Patent 4,802,108 which is incorporated by reference in the present application.

There are many, many journal articles which describe rank order filters generally and median rank order filters in particular. Enclosed are three such journal articles which are intended to be illustrative only of the information available to those skilled in the art. The references are:

1. *"LUM Filters: A Class of Rank-Order-Based Filters for Smoothing and Sharpening"*, by Russell C. Hardie and Charles G. Boncelet, IEEE TRANSACTIONS ON SIGNAL PROCESSING, Vol. 41, No. 3, March 1993, pp. 1061 – 1076;
2. *"Detail-Preserving Ranked-Order Based Filters for Image Processing"*, by Gonzalo R. Arce and Russell E. Foster, IEEE TRANSACTIONS ON ACOUSTICS, SPEECH, AND SIGNAL PROCESSING, Vol. 37, No. 1, January 1989, pp. 83 – 98; and,
3. *"Multiresolution Decomposition and Adaptive Filtering with Rank Order Based Filters – Application to Defect Detection –"*, by Phillippe Salembier, SIGNAL PROCESSING LABORATORY, Swiss Federal Institute of Technology, CH-1015 Lausanne, Switzerland, IEEE, July 1991, pp. 2389 – 2392.

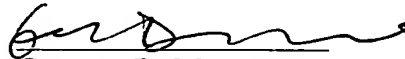
The disclosure of the present application specifically teaches that a preferred embodiment of the claimed method and apparatus of applicants employs rank order filters and median rank order filters. Given the state of the art with respect to such filters, as shown by the illustrative journal articles cited above and U.S. Patent 4,802,108, it is clearly apparent that applicants, at the time the application was filed had possession of the embodiment of their invention wherein rank-order filters are employed and that claims 3 and 8 satisfy the requirements for patentability established by the first paragraph of Section 112.

Reconsideration of these grounds of rejection and withdrawal thereof are respectfully requested.

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In summary, the claims have been shown to be proper in form for allowance and to recite subject matter which is patentably distinguishable over the references of record. Reconsideration of the application and allowance of the claims are in order and such actions are respectfully solicited.

Respectfully submitted,


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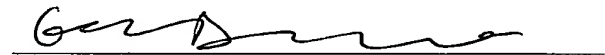
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Enclosures: (3 journal articles)

CERTIFICATE OF MAILING

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Date: July 9, 2003


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